FINAL REPORT

HUMAN HEALTH RISK ASSESSMENT
FORMER CELOTEX SITE
2800 S. SACRAMENTO AVE.
CHICAGO, ILLINOIS

Prepared for
City of Chicago Department of Environment
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February 7, 2007

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Subject: City of Chicago Sampling Data
Former Celotex Site – 2800 South Sacramento Avenue

To Whom It May Concern:

The City of Chicago Department of Environment is providing the following environmental reports for inclusion into the existing repository at the Marshall Square Branch Library, maintained by the U.S. Environmental Protection Agency, for the Former Celotex Site, located at 2800 South Sacramento Avenue:

- *Former Celotex Site – 2800 S. Sacramento Avenue, Phase II Subsurface Investigation*, prepared by URS, dated November 29, 2006.
- *Human Health Risk Assessment, Former Celotex Site, 2800 S. Sacramento Ave., Chicago, Illinois*, prepared by URS, dated February 7, 2007.

If you have questions or need additional information, please do not hesitate to contact me at (312) 744-3636.

Sincerely,

Leigh E. Peters, P.E.
Environmental Engineer III

cc: Jena Sleboda, USEPA

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ATTACHMENTS

ACRONYMS

ATSDR	Agency for Toxic Substances Disease Registry
CDOE	Chicago Department of Environment
COC	Chemical of Concern
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
C_{sat}	Saturation Concentration
ED	Exposure Duration
EF	Exposure Frequency
EFH	Exposure Factors Handbook
EPC	Exposure Point Concentration
HHRA	Human Health Risk Assessment
HSDB	Hazardous Substance Data Bank
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
IRIS	Integrated Risk Information System
Koc	Organic Carbon Partition Coefficient
Kow	Octanol Water Partition Coefficient
MOU	Memorandum of Understanding
NCEA	National Center for Environmental Assessment
PCB	Polychlorinated Biphenyl
PRG	Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference Dose
RFS	Request for Services
RO	Remediation Objective
SCEM	Site Conceptual Exposure Model
SF	Slope Factor
SSL	Soil Screening Level
TACO	Tiered Approach to Correction Action Objectives
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency

VOC Volatile Organic Compound

URS Corporation (URS) was directed by the Chicago Department of Environment (CDOE) to proceed with a human health risk assessment (HHRA) pursuant to CDOE's request for services (RFS) dated May 30, 2006. This HHRA is based upon the data collected by URS at the former Celotex property located at 2800 S. Sacramento Avenue (the Site) in Chicago, Illinois. The results of URS' investigation were presented in a letter report, dated November 15, 2006, and submitted to CDOE (URS, 2006). The HHRA was performed in accordance with relevant guidance provided by the United States Environmental Protection Agency (USEPA) and the Illinois Environmental Protection Agency in the following documents:

- *Risk Assessment Guidance for Superfund* (RAGS) (USEPA, 1989);
- *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (USEPA, 2002a);
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b);
- *Exposure Factors Handbook* (EFH) (USEPA, 1997);
- RAGS Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004a); and
- Tiered Approach to Corrective Action Objectives (TACO) (Illinois EPA, 2001) Illinois Administrative Code [IAC] Title 35, Subtitle G, Chapter I, Subchapter f, Part 742 (TACO Guidance).

The intent of this risk evaluation is to determine whether a layer of on-site gravel fill material is suitable for incorporation into an engineered barrier across the Site. It is URS' understanding that the barrier will ultimately allow the Site to be used for recreational purposes. Based on the future recreational land use of the Site, this HHRA was completed using the most conservative exposure scenario (residential) to determine if recreational receptors will be exposed to unacceptable concentrations at the Site. The residential land use scenario was used because it is more conservative and the exposure parameter values to estimate risk are widely accepted by both USEPA and IEPA. However, a recreational land use scenario was also evaluated for comparative purposes to determine risks that would be observed for a more realistic future recreational receptor.

1.0 TACO RISK SCREENING APPROACH

Although the presence of many chemicals may be identified in the environmental samples collected during site investigative activities, the results of an HHRA are typically driven by a few chemicals and exposure pathways. To streamline the HHRA process and focus efforts on important issues, several methods have been developed by the regulatory agencies and the scientific community for the identification of chemicals and pathways that contribute significantly to the total risks posed by a site. A tiered, risk-based approach was used for the selection of COPCs to be further evaluated in the formal HHRA for the Site. This approach is based on USEPA-developed methodology and follows standard HHRA procedures (USEPA, 1989; USEPA, 2002b). For this Site, IEPA's TACO approach was used to determine the list of chemicals that are most likely to drive risk at the Site. TACO is the IEPA's method for developing risk-based remediation objectives (ROs) for contaminated soil and groundwater, with consideration of Site conditions and identified land use and are calculated using USEPA guidance. ROs are designed to protect human health. ROs were used as readily-available risk-based concentrations to determine the list of chemicals that are most likely to drive risk for the Site. ROs were selected because they address residential and construction land use scenarios that are relevant to this Site.

TACO provides three options to develop ROs, of which selection depends on site-specific conditions and remediation goals:

- Exclusion of an exposure pathway;
- Use of area background concentrations; and
- A three-tiered approach for deriving ROs.

The HHRA represents a Tier 3 evaluation for the Site and consists of the following components:

Site-Specific Site Conceptual Exposure Model (SCEM). Attachment A presents the SCEM for the Site. The SCEM provides physical-chemical properties, and fate and transport characteristics of chemicals of concern (COCs) which were identified in the Tier 1 evaluation (URS, 2006). The SCEM also identifies potential sources, migration pathways, potential receptors, and exposure routes for COCs at the Site.

Tier 3 Formal Risk Assessment A Tier 3 formal risk assessment for carcinogenic polycyclic aromatic hydrocarbons (cPAHs) in gravel fines at the Site is presented in this report.

Exposure Route Exclusion. Section 3.0 of this report discusses justification for excluding certain exposure routes at the Site in accordance with TACO. Particularly, Section 3.2 presents a demonstration for excluding the soil migration to the uppermost aquifer route at the Site.

2.0 TIER 1 SCREENING RESULTS

A Tier 1 screening evaluation was conducted using laboratory data from gravel fines samples collected at the Site. The Tier 1 screening was performed based on the residential land use scenario, and the Tier 1 ROs were obtained from Appendix B, Table A of TACO (35 IAC 742). The soil ROs given in TACO are associated with three exposure routes: soil ingestion, soil inhalation, and soil migration-to-groundwater. All three exposure routes were used to develop the list of chemicals exceeding Tier 1 ROs.

Tier 1 screening indicates chemicals exceeding TACO Tier 1 soil ROs include methylene chloride, cPAHs (benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene), dieldrin, and chromium. Methylene chloride, cPAHs, dieldrin and chromium exceed the Tier 1 soil migration-to-groundwater ROs. The cPAHs exceed the Tier 1 residential soil ROs. Table 1 presents a summary of the Tier 1 RO exceedances.

Approaches to Address Tier 1 Exceedances Identified at the Site

The following approaches will be taken to address the Tier 1 exceedances identified at the Site.

Area/Media	COCs	Tier 1 ROs Exceeded	Approach to Address Tier 1 RO Exceedances	Addressed in
Gravel Fines/Fill	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Methylene chloride Dieldrin Chromium	Soil Migration-to-Groundwater	Exposure Route Exclusion	Section 3.0 of this Report
Gravel Fines/Fill	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Residential Ingestion	Tier 3 Formal Risk Assessment	Section 4.0 of this Report

3.0 EXPOSURE ROUTE EXCLUSION

This section evaluates potential for excluding exposure routes at the Site in accordance with Title 35 of the Illinois Administrative Code 35 (35 IAC 742), Subparts C and I.

3.1 Criteria for Exposure Route Exclusion

According to 35 IAC 742.300, the extent and concentrations of COCs must be characterized in order to evaluate pathways for exclusion. The extent and concentrations of COCs have been evaluated using data collected for this investigation (URS, 2006).

In addition, 35 IAC 742.305 specifies that no exposure route shall be excluded from consideration relative to a COC unless six additional requirements for demonstrating the absence of free product are met. These requirements are summarized in the table that follows.

35 IAC 742.305: Contaminant Source and Free Product Determination

Regulatory Requirement	Site Condition	Is Requirement Met?
(a) The sum of the concentrations of all organic COCs at each discrete sampling point shall not exceed the attenuation capacity of the soil (a default value of 6,000 mg/kg for soils within the top meter and 2,000 mg/kg for soils below one meter of the surface as set forth in 35 IAC 742.215);	The gravel fill sampling results indicated the soil attenuation capacity is not exceeded at the Site since the sum of the concentrations of all organic COCs at each sampling point did not exceed the lowest default natural organic carbon fraction (i.e., 6,000 mg/kg for surface, and 2,000 mg/kg for subsurface) as specified in 35 IAC 742.215 (b) (1) (A).	Yes
(b) The residual concentrations of any organic COCs remaining in the soil shall not exceed the soil saturation limit (C_{sat}) as determined under 35 IAC 742.220;	The concentrations of organic COCs were compared to the default C_{sat} values as given in Appendix A, Table A of TACO. No exceedances of C_{sat} were identified at the Site.	Yes
(c) Any soil which contains COCs shall not exhibit any of the characteristics of reactivity for hazardous waste as determined under 35 IAC 721.123;	No evidence exists to indicate that the fill materials exhibit any characteristics of reactivity as described in 35 IAC 721.	Yes
(d) Any soil which contains COCs shall not exhibit a pH less than or equal to 2.0 or greater than or equal to 12.5;	The pH levels of the gravel fill materials at the Site ranged from 8.9 to 11.9 (see Table 3 of URS, 2006).	Yes
(e) Any soil which contains COCs in the following list of inorganic chemicals or their salts shall not exhibit any of the characteristics of toxicity for hazardous waste as determined by 35 IAC 721.124, or an alternative method approved by the Agency: arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver.	No unusually high total concentrations of inorganics were found, except for chromium levels detected in two samples taken from sample locations S-40 and S-41 at depths less than 2 feet. The detections of chromium are just slightly above the migration to groundwater RO. The average concentration (15.5 milligrams per kilogram [mg/kg]) and 95% upper confidence limit (UCL) (16 mg/kg) for chromium are below the migration-to-groundwater RO. UCL calculations are provided as Table B-1 in Attachment B.	Yes
(f) If COCs include polychlorinated biphenyls (PCBs), the concentration of any PCBs in the soil shall not exceed 50 parts per million as determined by SW846 Methods.	Fifty-nine samples were analyzed for PCBs. PCBs were not detected above 50 parts per million, residential or construction worker remedial objectives for soil ingestion in any of the 59 samples analyzed.	Yes

The conditions of the on-site gravel fill material meet all the criteria for exposure route exclusion set forth in 35 IAC 742.300 through 305. Exclusion of exposure routes can be considered an option at the Site.

3.2 Soil Migration-to-Groundwater Route Exclusion

This section provides a demonstration pursuant to 35 IAC 742.925 to exclude the soil migration-to-groundwater route for the Site. The evaluation was conducted in light of the following:

- Existence of an engineered barrier;
- City of Chicago Groundwater Ordinances limiting groundwater use; and
- Physical, chemical and migration properties of the COCs

35 IAC 742.925 Demonstration of Exposure Route Exclusion

As indicated in 35 IAC 742.300(c), TACO allows the exclusion of exposure routes under a Tier 3 evaluation as set forth in 35 IAC 742.925. The 35 IAC 742.925 outlines the items that need to be addressed under the Tier 3 evaluation to demonstrate that there is no actual or potential impact of COCs to receptors via a particular exposure route. Herein, it is demonstrated that there is no impact of COCs to receptors from the migration to groundwater route at the Site. The regulatory information and associated site conditions are outlined below.

Regulatory Requirement	Technical Demonstration
35 IAC 742.925 (a) A description of the route evaluated.	The route being evaluated is the soil migration-to-groundwater route. The discussion provided below in (b) through (d) demonstrates that potential groundwater receptors would not be impacted by COCs in fill material at the Site through the soil migration-to-groundwater route.
35 IAC 742.925 (b) Description of the site and physical site characteristics.	The Site comprises a rectangular-shaped parcel with smaller areas protruding from the central portion of the Site, and occupies approximately 18.26 acres. The Site is covered by a layer of gravel fill material at approximate depths of 0.67-1.7 feet below ground surface. The source of the gravel is not known. Soil was observed beneath the gravel fill during sampling activities. It is URS' understanding that these soils may also have been brought on-site from an unknown source. The Site is currently used for storage of trailers and other vehicles.
35 IAC 742.925 (c) Discussion of the result and possibility of the route becoming active in the future.	The City of Chicago provides a restriction on the use of groundwater. The ordinance as outlined in the Memorandum of Understanding Between the City of Chicago and the Illinois Environmental Protection Agency (IEPA, 1997) prohibits the installation of new potable water supply wells and that the potable water supply must be from an approved water distribution system. The provisions of this ordinance are applicable to the Site. Therefore, the soil migration-to-groundwater route will not become active in the future unless the City of Chicago groundwater ordinance is rescinded.
35 IAC 742.925 (d) (1) & (2) Technical support including a discussion of the natural or man-made barriers to exposure through that route, calculations and modeling results.	This focus of the HHRA is on the gravel fines within the gravel surface cover at the Site. It is URS' understanding that the current gravel surface will be used as an engineered barrier. It is also assumed that for public park construction, the gravel layer would be covered with soil and grass which effectively renders all pathways associated with exposure to gravel fines incomplete.
35 IAC 742.925 (d) (3) & (4) Physical and chemical and contaminant migration properties of contaminants of concern.	Methylene chloride, cPAHs, dieldrin, and chromium were COCs at the Site that had soil migration-to-groundwater RO exceedances. The fate and transport characteristics of these COCs are described in the SCEM presented in Attachment A. Significant leaching of cPAHs and dieldrin from on-site fill materials is not expected because of their low mobility and/or high sorption rates. Volatilization and biodegradation are the dominant transformation processes for methylene chloride. Significant impacts from methylene chloride in the on-site fill material to the deeper regional groundwater and the subsequent migration of methylene chloride in groundwater to reach the potential receptors are not likely because of biodegradation and volatilization. In

Regulatory Requirement	Technical Demonstration
	addition, as indicated in URS' letter report (URS, 2006), the presence of methylene chloride in the samples collected during the field investigation may be attributed to laboratory contaminants.

Conclusion Regarding Exposure Route Exclusion

The evaluation concluded no current or potential future receptors are impacted or will be impacted by the COCs in gravel fines at the Site through the soil migration-to-groundwater route. Therefore, the soil migration-to-groundwater route can be excluded from further evaluation as long as continued compliance with the groundwater ordinance is observed.

4.0 TIER 3 – FORMAL RISK ASSESSMENT FOR CARCINOGENIC PAHS

URS conducted a formal risk assessment to quantitatively evaluate the potential health impacts associated with exposure to cPAHs detected in gravel fines at the Site. Elevated levels above TACO Tier 1 soil ingestion ROs were detected in several samples collected from the Site for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. However, all seven cPAHs were included in the risk assessment to address the additivity of these chemicals as they are considered similar-acting carcinogenic chemicals targeting the same organ (i.e., gastrointestinal system) according to 35 IAC 742 Appendix A, Table F.

The risk assessment was conducted in accordance with guidance provided in the following documents:

- *Risk Assessment Guidance for Superfund* (RAGS) (USEPA, 1989),
- *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (USEPA, 2002a),
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b),
- *Exposure Factors Handbook* (EFH) (USEPA, 1997),
- *RAGS Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2004a), and
- *Tiered Approach to Corrective Action Objectives* (TACO) (Illinois EPA, 2001).

Specifically, this risk assessment is intended to satisfy the requirements of 35 IAC 742.915 for the preparation of formal risk assessments. The formal HHRA is based specifically upon USEPA RAGS guidance and other pertinent documentation as indicated above. Information regarding sampling and analysis, extent of Tier 1 RO exceedances, and characteristics of the COCs are provided in the letter report "*Project Category 4: Additional Specialized*

Environmental & Engineering Services, Former Celotex Site – 2800 S. Sacramento Avenue, Chicago, Illinois" (URS, 2006).

The main components of the risk assessment are as follows:

- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Uncertainty Evaluation.

This formal risk assessment represents a site-specific risk assessment relating to current and potential future land use scenarios by using the following parameters:

- Conservative default exposure parameters;
- Site-specific exposure data relative to current and future land use; and
- Site-specific soil physical properties

4.1 Exposure Assessment

The following components must exist for an exposure pathway to be complete:

- A source and mechanism of chemical release;
- A retention or transport medium;
- A point of potential human contact with the impacted medium; and
- An exposure route at the contact point.

If one or more of these components are absent, the exposure pathway is incomplete. A potentially complete exposure pathway is one in which one or more of the four components is currently absent, but may become present under some future scenarios. In this formal risk assessment, the exposure assessment was conducted for both complete and potentially complete exposure pathways at the Site (Section 4 of Attachment A).

The Site is being evaluated based on guidance provided by CDOE indicating that the future land use of the Site will be recreational. Therefore, potential receptors include adult and child recreational users. Based on the current land use of industrial and anticipated future land use of recreational, and presence of sensitive populations, such as the elderly or small children, the land use selected to model risks at the Site is the residential land use scenario. The exposure routes evaluated for residential receptors are ingestion, inhalation of cPAHs in gravel fines, and dermal contact with cPAHs in gravel fines.

Although there are current industrial/commercial workers and it is possible for trespassers to access the Site, these exposure scenarios were not evaluated for this HHRA. The risks calculated for the residential scenario are based on the most conservative exposure assumptions for all current and future receptors to the Site. Therefore, the residential scenario is considered protective of current industrial/commercial workers and potential trespassers as well as future recreational receptors.

For the purpose of this formal HHRA, residential receptor exposure was evaluated using a combination of default exposure parameter values to represent a conservative, yet reasonably site-specific exposure scenario. Some of the parameters, e.g., the 95% UCL of the mean, are meant to represent high-end exposure by using upper-bound estimates for exposure parameter values. The site-specific parameter values represent more reasonable exposure conditions that are applicable to the current and future land use scenarios.

4.1.1 Exposure Point Concentrations

The exposure point concentration (EPC) for each of the seven cPAHs was derived through statistical analysis of the data collected from the Site. In total, 59 sample results were used for calculating cPAH EPCs.

A statistical analysis was conducted using USEPA's ProUCL software (USEPA, 2004b), which follows guidance for calculating UCLs presented in *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (USEPA, 2002a). The EPC is generally based on the 95% UCL of the arithmetic mean. Different statistical methods were applied to calculate the 95% UCL based on sample size, percentage of detections, and distribution of the data set.

- In general, if the frequency of detection was less than 50%, non-parametric statistical methods were used to estimate the EPC. If the frequency of detection was greater than 50%, the raw data or log-normally transformed data were tested for normality and an appropriate method was used to estimate the EPC.
- For non-detect results, one-half of the reporting limit was used as the concentration in the statistical calculation (USEPA, 1992).
- When both original and field duplicate sample results were available, the average value of the original and duplicate data was used to represent the constituent concentration for a given location and depth.

The analytical data for the gravel fines samples collected for this investigation were provided in URS, 2006. A figure depicting the locations of the samples collected at the Site is also provided as Figure 1.

A summary of EPCs calculated for the HHRA is provided in Table 2. The output files for the EPC calculations for gravel fines are presented in Attachment B, Tables B-2 to B-8.

4.1.2 Estimating Chemical Intakes

The equations used to estimate exposure intakes of cPAHs were obtained by solving the Soil Screening Level (SSL) equations for the target risk term as set forth in TACO, Appendix C. Sources of the exposure factors include recommended default values from TACO. For calculation of dermal contact risk, Equations 3.11, 3.12, 3.21, 4.2, and 5.1 from RAGS Part E (USEPA, 2004a) were used.

To be conservative, chemical intakes were estimated using the 95% UCL of the mean as the EPC and TACO default values for exposure frequency, exposure duration, body weight and averaging time.

Exposure parameter values and equations used to estimate risk are presented in Tables 3 – 7 for the residential scenario. For comparative purposes, site-specific exposure parameter values for the recreational scenario are presented in Tables 9 – 11.

4.1.3 Toxicity Assessment

Chemical intake estimates are combined with descriptors of the chemical's potential toxicity, referred to as toxicity values. The result is an estimate of potential health risks associated with the exposure. Only carcinogenic toxicity is considered in this formal risk assessment for cPAHs, as noncarcinogenic toxicity values, e.g., reference doses (RfDs), have not been derived.

The toxicity value describing potential carcinogenicity of a chemical is called a cancer slope factor (SF) expressed in the units of $(mg/kg\text{-}day)^{-1}$. An SF represents an upper bound estimate of the probability that an individual may develop cancer following exposures to the particular chemical. Toxicity values were obtained from the following sources.

1. Integrated Risk Information System (IRIS) on-line database (USEPA, 2006)
2. Provisional toxicity values obtained from National Center for Environmental Assessment (NCEA), as published in USEPA Region 9 Preliminary Remediation Goals (PRGs) (USEPA, 2004c)

Toxicity values and chemical-specific values used in the risk calculations are provided in Table 3.

4.2 Risk Characterization

Cancer risks are expressed as the excess probability of cancer as a result of chemical exposure, and were estimated by multiplying the chemical intake by the SF, or Risk = Intake × SF. Chemical-specific cancer risks were then summed for each pathway to yield a total excess risk for carcinogenic effects.

Acceptability of the overall cancer risk is typically gauged by comparing the risk estimate with the risk range of 1×10^{-4} to 1×10^{-6} (excess cancer risks of one in ten thousand to one in one million). This risk range is the target risk level established by the National Oil and Hazardous Substances Contingency Plan for evaluating the need for and the extent of remediation (USEPA, 1990). Remediation is typically not warranted if the cumulative site risk is within this range.

The total cancer risk was estimated for potential future residential receptors exposure through the ingestion and inhalation of cPAHs in gravel fines at the Site (Tables 4 and 5). The calculated total cancer risks were 5×10^{-5} (Table 8). This risk estimate for exposures to gravel fines is above the TACO default risk level of 1×10^{-6} for no further action and within the acceptable risk range of 1×10^{-4} to 1×10^{-6} established by both IEPA and USEPA. However, it must be noted that risk was calculated for the more conservative residential land use scenario and risks associated with surficial exposure for the planned future recreational land use scenario would be much lower. Tables 9 – 11 present the risks to an adolescent (6 – 18 years of age) recreational receptor exposed to cPAHs in gravel fines. Risk for this receptor is 2×10^{-6}, which is just slightly above the lower end of the target risk range used by both the IEPA and USEPA.

4.3 Uncertainty Analysis

The formal risk assessment for current and future residential exposures is a conservative assessment of potential health risks posed by cPAHs in soil. The primary sources of uncertainty are discussed below.

It has been widely recognized by USEPA that repeated use of upper bound values for exposure parameters could lead to a substantial overestimate of the actual risk. Researches have reported that this approach could yield risk estimates for individuals that lie well above the intended 95th percentile (Finley et al., 1993). This conservative approach can readily lead to unnecessary overprotection and misplacing cleanup activities. This risk assessment used the default values and therefore, more conservative values for exposure frequency (EF) and exposure duration (ED). Based on the assumptions for exposure frequency and exposure duration for recreational receptors, site-specific exposure patterns are as much as one-half of IEPA's default values. Estimates of risk using site-specific information include the use of an ED of 12 years and an EF of 52 days per year results in a risk estimate of 2×10^{6}, which is within both the IEPA and USEPA target risk range[1]. Calculations using site-specific values are presented in Tables 8 to 10.

The assumptions made regarding the degree to which exposure occurs are conservative. The upper bound estimates of detected concentrations in surficial fill materials (i.e., 95% UCLs of the mean) were used as EPCs in the risk evaluation. The use of the 95% UCL of the mean is consistent with risk assessment guidance and represents an upper bound value; thus, this approach contributes to the conservatism in the overall evaluation.

[1] The recreational adolescent exposure duration is assumed to range in age from 7 to 18. Therefore, total exposure duration is 12 years. The exposure frequency is a conservative assumption which assumes adolescents will be present 3 days per week during June, July, and August and 1 day per week during April, May, September, and October).

There are no published dermal SFs available for any chemicals in any USEPA database. However, based on literature evidence, cPAHs have been shown to induce systemic toxicity and tumors at distant organs. For this reason, the lack of a dermal toxicity value may not accurately predict risk for receptors exposed to cPAHs. Therefore, *RAGS Part E* (USEPA, 2004), only recommends a qualitative evaluation of the carcinogenic effects of PAHs. Although a quantitative evaluation was completed for this HHRA, the actual risks associated with this exposure pathway are unknown.

The oral and inhalation toxicity values applied in this risk assessment were derived by USEPA. The methodology by which toxicity values are derived is intentionally conservative. Use of the toxicity values has likely resulted in an overestimation of potential health risks.

4.4 Formal Risk Assessment Conclusions

A formal risk assessment for the cPAHs detected in gravel fines at the Site was conducted in accordance with USEPA risk assessment methodologies and IEPA's TACO regulations, which are based upon USEPA methodologies. Site-specific risk estimates were calculated for off-site residential receptors exposed to cPAHs in gravel fines. The conservative risk estimate associated with this receptor was calculated to be 5×10^{-5}. This estimate is above the default risk level of 1×10^{-6} used in TACO for no further action but within the risk range of 1×10^{-4} to 1×10^{-6} considered to be acceptable by USEPA and IEPA. Site-specific calculations of risks associated with recreational exposure to cPAHs in gravel fines is 2×10^{-6} which is slightly above the IEPA default risk level for no further action but within USEPA target risk range for no further action.

Therefore, based on the findings of the HHRA, the potential adverse health effects associated with exposures to concentrations of cPAHs in gravel fines are within acceptable levels and the Site is acceptable for recreational land use.

5.0 SUMMARY OF RISK EVALUATION

The risk evaluation for the Site was conducted in accordance with 35 IAC 742. The results of the risk evaluation are summarized below.

- No further action is needed for detections of cPAHs in gravel fines. The Tier 3 evaluation indicates the risks associated with exposures to these chemicals in gravel fines are within acceptable limits.
- No further action is needed for methylene chloride, cPAHs, dieldrin, and chromium in gravel fines. Based on the existence of the City of Chicago groundwater ordinance preventing the use of groundwater beneath the Site and the fate and transport characteristics for these chemicals, impacts to off-site residential receptors is non-existent.

5.0 REFERENCES

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Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Chicago Background Levels	Residential Route Specific Values for Soil		Construction Worker Route Specific Values for Soil		Soil Component of Groundwater Ingestion Exposure Route Values		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Volatile Organic Compounds		Ingestion	Inhalation	Ingestion	Inhalation	Class I	Class II											
Methylene chloride	NA	85	13	12,000	34	0.02	0.2	0.038 UJ	0.021 UJ	0.017 UJ	0.04 UJ	0.056 UJ	0.045 UJ	0.018 UJ	0.023 UJ	0.021 UJ	0.027 UJ	0.022 UJ
Semivolatile Organic Compounds																		
Benz(a)anthracene	1.1	0.9	NE	170	NE	2	8	**3.4**	**1.8**	**6.2**	**3**	***1.1 J***	***0.67***	**2.2**	**3.8**	**1.8**	**1.2**	**1.9**
Benzo(a)pyrene	1.3	0.09	NE	17	NE	8	82	**4.9**	**2.2**	**6.3**	**2.6**	***0.89 J***	***0.59***	**1.6**	**4.5**	***1.2***	***0.88***	***1.2***
Benzo(b)fluoranthene	1.5	0.9	NE	170	NE	5	25	**5.3**	**2.6**	**7.1**	**3.2**	***1.2 J***	0.72	**2**	**4.7**	**1.7**	***1.1***	**1.7**
Benzo(k)fluoranthene	1	9	NE	1,700	NE	49	250	3	1.2	6.4	1.6	0.61 J	0.43	0.96	3.2	0.74	0.7	0.69
Chrysene	1.1	88	NE	17,000	NE	160	800	3.7	1.9	5.9	2.7	1 J	0.68	2.1	4	1.9	1.3	1.8
Dibenz(a,h)anthracene	0.2	0.09	NE	17	NE	2	7.6	**0.96**	**0.49**	**1**	**0.55**	***0.19 J***	***0.12***	**0.32**	**0.62**	**0.24**	***0.13***	**0.24**
Indeno(1,2,3-cd)pyrene	0.86	0.9	NE	170	NE	14	69	**3.5**	**1.3**	**3.7**	**1.4**	0.38 J	0.32	0.83	**2.8**	0.67	0.52	0.65
Metals																		
Chromium	16.2	230	270	4,100	690	21-36	NE	12	16	17	14	14	13	16	13	13	14	12
Pesticides																		
Dieldrin	NA	0.04	1	7.8	3.1	0.004	0.2	0.0033 U	0.0032 U	0.0032 U	0.0033 U	0.0032 U	0.0033 U	**0.0072**	0.0033 U	0.005	0.0033 U	0.0033 U

Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Chicago Background Levels	Residential Route Specific Values for Soil		Construction Worker Route Specific Values for Soil		Soil Component of Groundwater Ingestion Exposure Route Values		S12	S13	S14	S15	S16	S17	S18	S19	S20
Volatile Organic Compounds		Ingestion	Inhalation	Ingestion	Inhalation	Class I	Class II									
Methylene chloride	NA	85	13	12,000	34	0.02	0.2	0.084 UJ	0.056 UJ	0.079 UJ	0.02 UJ	0.05 UJ	0.052 UJ	0.039 UJ	0.026 UJ	0.06 UJ
Semivolatile Organic Compounds																
Benz(a)anthracene	1.1	0.9	NE	170	NE	2	8	1.4	0.86	0.67	1.2	0.67	2.6	1.3 J	9.9	2.4
Benzo(a)pyrene	1.3	0.09	NE	17	NE	8	82	0.86	0.59	0.48	0.72	0.42	1.4	0.74 J	7	1.7
Benzo(b)fluoranthene	1.5	0.9	NE	170	NE	5	25	1.3	0.85	0.72	1.1	0.57	2.1	1.1 J	8.7	2.1
Benzo(k)fluoranthene	1	9	NE	1,700	NE	49	250	0.53	0.3	0.26	0.4	0.32	0.89	0.43 J	4.4	1.3
Chrysene	1.1	88	NE	17,000	NE	160	800	1.4	0.88	0.72	1.2	0.67	2.4	1.3 J	8.6	2.3
Dibenz(a,h)anthracene	0.2	0.09	NE	17	NE	2	7.6	0.12	0.076	0.11	0.099	0.1	0.33	0.17 J	0.91	0.42
Indeno(1,2,3-cd)pyrene	0.86	0.9	NE	170	NE	14	69	0.49	0.33	0.28	0.4	0.24	0.88	0.46 J	3	0.92
Metals																
Chromium	16.2	230	270	4,100	690	21-36	NE	16	17	13	15	12	19	17	16	19
Pesticides																
Dieldrin	NA	0.04	1	7.8	3.1	0.004	0.2	0.0033 U	0.0032 U	0.0043	0.0033 U	0.0033 U	0.0053	0.0033 U	0.0033 U	0.0046

Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Chicago Background Levels	Residential Route Specific Values for Soil		Construction Worker Route Specific Values for Soil		Soil Component of Groundwater Ingestion Exposure Route Values		S21	S22	S23	S24	S25	S26	S-27	S-28	S-29	S-30	S-31
Volatile Organic Compounds		Ingestion	Inhalation	Ingestion	Inhalation	Class I	Class II											
Methylene chloride	NA	85	13	12,000	34	0.02	0 2	0 029 UJ	0 042 UJ	0 022 UJ	0.049 UJ	0.046 UJ	0 033 UJ	0.04 UJ	0 055 UJ	0 029 UJ	0 073 UJ	0.038 UJ
Semivolatile Organic Compounds																		
Benz(a)anthracene	1.1	0.9	NE	170	NE	2	8	0 84	1.1	0 25	1.4	2.2	0 52	2.9	1.3	0.79 J	1.1	2.5
Benzo(a)pyrene	1.3	0 09	NE	17	NE	8	82	0.66	0.85	0.22	1.2	1.9	0 44	2.3	1	0.64 J	1	2.2
Benzo(b)fluoranthene	1.5	0.9	NE	170	NE	5	25	0.85	1.2	0.29	1.3	2.3	0 56	3.1	1.2	0 89 J	1.3	2.7
Benzo(k)fluoranthene	1	9	NE	1,700	NE	49	250	0 5	0 75	0.14	1	1.4	0.43	1 2	0.69	0 34 J	0.83	1 5
Chrysene	1.1	88	NE	17,000	NE	160	800	0.86	1.1	0.25	1.3	2.2	0 54	2 9	1.3	0.78	1.2	2 2
Dibenz(a,h)anthracene	0.2	0.09	NE	17	NE	2	7.6	0.14	0.19	0.073	0.26	0.38	0.12	0.32	0.19	0.13	0.14	0.42
Indeno(1,2,3-cd)pyrene	0.86	0.9	NE	170	NE	14	69	0 31	0 47	0.14	0 63	0.95	0 24	1.1	0 49	0.33 J	0.57	1.1
Metals																		
Chromium	16.2	230	270	4,100	690	21-36	NE	13	14	11	17	17	18	16	16	17	19	25
Pesticides																		
Dieldrin	NA	0 04	1	7.8	3.1	0 004	0.2	0.0033 U	0.006	0 0033 U	0.0034	0 0036	0 0032 U	0.0037	0.0033 U	0 0033 U	0 0033 U	0.0063

Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Chicago Background Levels	Residential Route Specific Values for Soil		Construction Worker Route Specific Values for Soil		Soil Component of Groundwater Ingestion Exposure Route Values		S-32	S-33	S-34	S-35	S-36	S-37	S-38	S-39	S-40	S-41	S-42
Volatile Organic Compounds		Ingestion	Inhalation	Ingestion	Inhalation	Class I	Class II											
Methylene chloride	NA	85	13	12,000	34	0.02	0.2	0.038 UJ	0.068 UJ	0.06 UJ	0.059 UJ	0.062 UJ	0.059 UJ	0.052 UJ	0.041 UJ	0.034 UJ	0.061 UJ	0.037 UJ
Semivolatile Organic Compounds																		
Benz(a)anthracene	1.1	0.9	NE	170	NE	2	8	2	0.93	0.89	0.35 J	3	1.1	0.77	1.9	1.1	1.9	0.6 J
Benzo(a)pyrene	1.3	0.09	NE	17	NE	8	82	1.5	0.94	0.77	0.31 J	2.8	0.59	0.7	1.2	0.83	1.3	0.45 J
Benzo(b)fluoranthene	1.5	0.9	NE	170	NE	5	25	2	1.3	0.92	0.39 J	1.8	0.66	0.69	1.7	1.1	1.8	0.58 J
Benzo(k)fluoranthene	1	9	NE	1,700	NE	49	250	0.92	0.75	0.67	0.24 J	1.2	0.48	0.67	0.94	0.82	0.85	0.33 J
Chrysene	1.1	88	NE	17,000	NE	160	800	2	1	0.65	0.4 J	2.9	1.2	0.84	2	1.3	2	0.61 J
Dibenz(a,h)anthracene	0.2	0.09	NE	17	NE	2	7.6	0.32	0.22	0.19	0.084 J	0.38	0.15	0.084	0.22	0.24	0.28	0.093 J
Indeno(1,2,3-cd)pyrene	0.86	0.9	NE	170	NE	14	69	0.78	0.5	0.44	0.2 J	1.4	0.28	0.39	0.61	0.48	0.73	0.25 J
Metals																		
Chromium	16.2	230	270	4,100	690	21-36	NE	17	16	16	16	11	17	14	18	22	21	15
Pesticides																		
Dieldrin	NA	0.04	1	7.8	3.1	0.004	0.2	0.0032	0.0033 U	0.0033 U	0.0033 U	0.0055	0.0057	0.0073	0.0046	0.0047	0.005	0.0033 U

Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Chicago Background Levels	Residential Route Specific Values for Soil		Construction Worker Route Specific Values for Soil		Soil Component of Groundwater Ingestion Exposure Route Values		S-43	S-44	S-45	S-46	S-47	S-48	S-49	S-50	S-51	S-52	S-53	S-54
Volatile Organic Compounds		Ingestion	Inhalation	Ingestion	Inhalation	Class I	Class II												
Methylene chloride	NA	85	13	12,000	34	0.02	0.2	0.05 UJ	**0.038 J**	**0.028 J**	0.018 J	**0.034 J**	**0.057 J**	**0.034 J**	**0.048 J**	**0.028 J**	**0.06 J**	**0.025 J**	**0.059**
Semivolatile Organic Compounds																			
Benz(a)anthracene	1.1	0.9	NE	170	NE	2	8	**1.3**	**1.1**	**1.1**	**1.3**	0.87	0.84	0.78	**1.1**	**1.1**	**1.1**	0.65	0.64
Benzo(a)pyrene	1.3	0.09	NE	17	NE	8	82	**0.56**	**0.9**	**0.77**	**0.86**	**0.9**	**0.81**	**0.82**	**0.79**	**0.8**	**0.53**	**0.39**	**0.41**
Benzo(b)fluoranthene	1.5	0.9	NE	170	NE	5	25	0.79	**1.2**	**1.4**	**1.1**	**1.2**	**1.1**	*0.76*	**1**	**1.2**	0.75	0.49	0.56
Benzo(k)fluoranthene	1	9	NE	1,700	NE	49	250	0.58	0.79	0.68	0.85	0.54	0.46	0.81	0.7	0.92	0.53	0.43	0.37
Chrysene	1.1	88	NE	17,000	NE	160	800	1.4	1.1	1.2	1.5	0.92	0.8	0.86	1	1.1	1.2	0.68	0.65
Dibenz(a,h)anthracene	0.2	0.09	NE	17	NE	2	7.6	**0.19**	**0.19**	**0.18**	0.24	0.22	0.18	0.25	0.12	**0.17**	**0.18**	**0.11**	**0.11**
Indeno(1,2,3-cd)pyrene	0.86	0.9	NE	170	NE	14	69	0.33	0.52	0.34	0.47	0.52	0.45	0.5	0.39	0.4	0.33	0.26	0.27
Metals																			
Chromium	16.2	230	270	4,100	690	21-36	NE	14	16	16	15	16	15	16	14	15	17	15	13
Pesticides																			
Dieldrin	NA	0.04	1	7.8	3.1	0.004	0.2	**0.0083**	**0.0053**	0.0033 U	0.0033 U	0.0033	0.0033 U	0.0036	**0.0073**	0.0033 U	0.0033 U	0.0032 U	0.0033

Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Chicago Background Levels	Residential Route Specific Values for Soil		Construction Worker Route Specific Values for Soil		Soil Component of Groundwater Ingestion Exposure Route Values		S-55		S-56		S-57		S-58		S-59
		Ingestion	Inhalation	Ingestion	Inhalation	Class I	Class II									
Volatile Organic Compounds																
Methylene chloride	NA	85	13	12,000	34	0 02	0.2	0.068	J	0.074	J	0.031	J	0.059	J	0.094 J
Semivolatile Organic Compounds																
Benz(a)anthracene	1.1	0.9	NE	170	NE	2	8	1.2	J	1.4		1.6 J		0.77		1.1
Benzo(a)pyrene	1.3	0.09	NE	17	NE	8	82	0.92 J		0.76		0.71 J		0.6		0.99
Benzo(b)fluoranthene	1.5	0.9	NE	170	NE	5	25	1.3		1.1		0.83		0.78		1.4
Benzo(k)fluoranthene	1	9	NE	1,700	NE	49	250	0.48		0.68		0.59		0 6		0 76
Chrysene	1.1	88	NE	17,000	NE	160	800	1		1 4		1 7 J		0 79		1 2
Dibenz(a,h)anthracene	0.2	0.09	NE	17	NE	2	7.6	0.16		0.19		0.26		0.2		0.22
Indeno(1,2,3-cd)pyrene	0.86	0.9	NE	170	NE	14	69	0.5		0.37		0.5		0.36		0 54
Metals																
Chromium	16.2	230	270	4,100	690	21-36	NE	12		11		16		13		14
Pesticides																
Dieldrin	NA	0.04	1	7.8	3.1	0.004	0.2	0.0036		0.0032	U	0.01		0 0033	U	0.0033 U

Table 1
Chemical Concentrations Exceeding TACO Tier I ROs
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Notes:

Concentrations are in milligrams per kilogram (mg/kg)
Bold and shaded values exceed Migration to Class I Groundwater ROs.
Black Bold and shaded values exceed Residental and/or Construction Worker ROs.
Italicized values exceed Residential and or Construction Worker ROs but are below Chicago Background Levels.
Values shown within a bold cell. [ ] = also exceed Migration to Class I Groundwater ROs.
Ranges for certain Migration to Groundwater ROs are pH-based according to TACO Section 742 Appendix B, Table C.

NE – Not Established
NA – Not Analyzed
J – Indicates an estimated concentration because of results below the sample reporting limit, or results where QC criteria were not met
UJ – Indicates that the analyte was not detected at or above the sample reporting limit. However, because of QC issues, the reporting limit is approximate and may or may not represent the actual limit of reporting necessary to accurately and precisely measure the analyte in the sample.
R – Result Rejected. Presence or absence of compound cannot be determined

Table 2
Exposure Point Concentration - Gravel Fines
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Analyte	Maximum Concentration (mg/kg)	Average Concentration (mg/kg)	95% UCL (mg/kg)	Distribution	Statistic used for 95% UCL	Rationale	Selected EPC (mg/kg)
Benz(a)anthracene	9.90E+00	1.62E+00	2.46E+00	non-parametric	Use 95% Chebyshev (Mean, Sd) UCL	UCL<Max	2.46
Benzo(a)pyrene	7.00E+00	1.30E+00	2.06E+00	non-parametric	Use 95% Chebyshev (Mean, Sd) UCL	UCL<Max	2.06
Benzo(b)fluoranthene	8.70E+00	1.62E+00	2.48E+00	non-parametric	Use 95% Chebyshev (Mean, Sd) UCL	UCL<Max	2.48
Benzo(k)fluoranthene	6.40E+00	9.45E-01	1.52E+00	non-parametric	Use 95% Chebyshev (Mean, Sd) UCL	UCL<Max	1.52
Chrysene	8.60E+00	1.60E+00	1.84E+00	non-parametric	H-UCL	UCL<Max	1.84
Dibenz(a,h)anthracene	1.00E+00	2.54E-01	2.91E-01	parametric	H-UCL	UCL<Max	0.29
Indeno(1,2,3-c,d)pyrene	*3.70E+00*	*7.21E-01*	*1.15E+00*	non-parametric	*Use 95% Chebyshev (Mean, Sd) UCL*	UCL<Max	1.15

Notes:
All units are milligrams per kilogram (mg/kg).
EPC = Exposure Point Concentration
UCL = Upper Confidence Limit
MVUE = Minimum Variance Unbiased Estimator
NA = Not Applicable

Table 3
Chemical-Specific and Toxicity Values
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Chemical		Solubility in Water S (mg/L)	Dimensionless Henry's Law Constant H' (unitless)	Organic Carbon/Water Partition Coefficient Koc (cm^3/g)	Diffusion Coefficient in Air D_{air} (cm^2/s)	Diffusion Coefficient in Water D_{water} (cm^2/s)	Gastrointestinal Absorption Efficiency ABS_{gi} (unitless)	Dermal Absorption Fraction ABSd unitless	Chronic Oral Reference Dose RfD_o [2] (mg/kg-dy)	Chronic Inhalation Reference Concentration RfC [2] (mg/m^3)	Oral Slope Factor SF_o $(mg/kg\text{-}dy)^{-1}$	Inhalation Slope Factor SF_i $(mg/kg\text{-}dy)^{-1}$	Inhalation Unit Risk UR_i $(\mu g/m^3)^{-1}$
Benz(a)anthracene	Car	9.40E-03 [1]	1.37E-04 [1]	3.98E+05 [1]	5.10E-02 [1]	9.00E-06 [1]	1 00E+00 [2]	1 30E-01 [3]	NA	NA	7.30E-01 NCEA	NA IRIS	NA IRIS
Benzo(a)pyrene	Car	1 62E-03 [1]	4.63E-05 [1]	1.02E+06 [1]	4 30E-02 [1]	9 00E-06 [1]	1.00E+00 [2]	1 30E-01 [3]	NA	NA	7 30E+00 IRIS	3.1 NCEA	8.86E-04 NCEA
Benzo(b)fluoranthene	Car	1.50E-03 [1]	4.55E-03 [1]	1.23E+06 [1]	2.26E-02 [1]	5.56E-06 [1]	1.00E+00 [2]	1 30E-01 [3]	NA	NA	7.30E-01 NCEA	NA IRIS	NA IRIS
Benzo(k)fluoranthene	Car	8.00E-04 [1]	3.40E-05 [1]	1.23E+06 [1]	2.26E-02 [1]	5.56E-06 [1]	1 00E+00 [2]	1.30E-01 [3]	NA	NA	7.30E-02 NCEA	NA IRIS	NA IRIS
Chrysene	Car	1 60E-03 [1]	3 88E-03 [1]	3.98E+05 [1]	2.48E-02 [1]	6.21E-05 [1]	1 00E+00 [2]	1 30E-01 [3]	NA	NA	7.30E-03 NCEA	NA IRIS	NA IRIS
Dibenz(a,h)anthracene	Car	2.49E-03 [1]	6 03E-07 [1]	3.80E+06 [1]	2.02E-02 [1]	5.18E-06 [1]	1 00E+00 [2]	1.30E-01 [3]	NA	NA	7 30E+00 NCEA	NA IRIS	NA IRIS
Indeno(1,2,3-c,d)pyrene	Car	2.20E-05 [1]	6.56E-05 [1]	3.47E+06 [1]	1.90E-02 [1]	5.66E-06 [1]	1.00E+00 [2]	1.30E-01 [3]	NA	NA	7 30E-01 NCEA	NA IRIS	NA IRIS

Notes:
[1] Appendix C, Table E of TACO (Illinois EPA, 2001).
[2] USEPA, 2004. *RAGS, Part E*, Exhibit 4-1. The % Absorbed ABS_{gi} is greater than 50% RAGSE recommends no adjustment for chemicals in this category.
[3] USEPA, 2004. *RAGS, Part E*, Exhibit 3-4. Recommended dermal absorption fraction from soil benzo(a)pyrene and other PAHs
IRIS = U.S. EPA's Integrated Risk Information System (http //www.epa.gov/iris)
Car = Carcinogen
NCEA = EPA-NCEA Regional Support provisional value
NA = Not available.

Table 4
Risk Calculation for the Ingestion Route for Gravel Fines
Residential Land Use
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Residential Land Use - Gravel Fines

Equation:

$$Risk_{soiling} = \frac{Csoil \times SF_o \times CF_2 \times EF \times IFsoil\text{-}adj}{AT_c \times CF_1}$$

where:

C_{soil} = Concentration in Soil (mg/kg)	Calculated, 95% UCL	(See Table 2)
SF_o = Oral Slope Factor $(mg/kg.day)^{-1}$	Chemical-specific	(See Table 3)
CF_2 = Unit conversion Factor (kg/mg)	1E-06	
EF = Exposure frequency (dy/yr)	350	TACO Default for residential land use
$IF_{soil\text{-}adj}$ = Age-adjusted Soil Ingestion Factor for Carcinogens (mg-yr/kg-d)	114	TACO Default for residential land use
BW= Body Weight (kg)	70	TACO Default
AT_c = Averaging Time (yr)	70	TACO Default
CF_1 = Unit conversion factor (dy/yr)	365	

Chemical	Csoil (mg/kg)	SF_o $(mg/kg.day)^{-1}$	CF_2 (kg/mg)	EF (dy/yr)	IFsoil-adj mg-yr/kg-d	AT_c (yr)	CF_1 (dy/yr)	Risk
Benz(a)anthracene	2.46	7.30E-01	1.0E-06	350	114	70	365	**2.80E-06**
Benzo(a)pyrene	2.06	7.30E+00	1.0E-06	350	114	70	365	**2.35E-05**
Benzo(b)fluoranthene	2.48	7.30E-01	1.0E-06	350	114	70	365	**2.83E-06**
Benzo(k)fluoranthene	1.52	7.30E-02	1.0E-06	350	114	70	365	**1.73E-07**
Chrysene	1.84	7.30E-03	1.0E-06	350	114	70	365	**2.10E-08**
Dibenz(a,h)anthracene	0.29	7.30E+00	1.0E-06	350	114	70	365	**3.32E-06**
Indeno(1,2,3-c,d)pyrene	1.15	7.30E-01	1.0E-06	350	114	70	365	**1.31E-06**
							Total Pathway Risk	**3E-05**

Table 5
Risk Calculations for Inhalation Route for Gravel Fines
Residential Receptors
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Residential Land Use - Gravel Fines

Equation:

$$Risk_{soilinh} = \frac{Csoil \times URF \times CF_2 \times EF \times ED \times [(1/VF) + (1/PEF)]}{AT_c \times CF_1}$$

where:

C_{soil} =	Concentration in Soil (mg/kg)	Calculated, 95% UCL	(See Table 2)
URF =	Inhalation Unit Risk Factor(($\mu g/m^3)^{-1}$	See Table 3	
CF_2 =	Unit conversion Factor (μg/mg)	1000	
EF =	Exposure frequency (dy/yr)	350	TACO default
ED =	Exposure duration (yr)	30	TACO default
VF =	Volatilization Factor (m^3/kg)	calculated	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	TACO default for residential land use
BW =	Body Weight (kg)	70	TACO default
AT_c =	Averaging Time (yr)	70	TACO default
CF_1 =	Unit conversion factor (dy/yr)	365	

Chemical	Csoil (mg/kg)	URF ($\mu g/m^3)^{-1}$	CF_2 (μg/mg)	EF (dy/yr)	ED (yr)	VF (m^3/kg)	PEF (m^3/kg)	AT_c (yr)	CF_1 (dy/yr)	Risk
Benz(a)anthracene	2.46	NA	1000	350	30	9.80E+06	1.32E+09	70	365	**NA**
Benzo(a)pyrene	2.06	8.86E-04	1000	350	30	1.57E+07	1.32E+09	70	365	**4.82E-08**
Benzo(b)fluoranthene	2.48	NA	1000	350	30	2.02E+07	1.32E+09	70	365	**NA**
Benzo(k)fluoranthene	1.52	NA	1000	350	30	1.03E+06	1.32E+09	70	365	**NA**
Chrysene	1.84	NA	1000	350	30	4.01E+07	1.32E+09	70	365	**NA**
Dibenz(a,h)anthracene	0.29	NA	1000	350	30	4.01E+07	1.32E+09	70	365	**NA**
Indeno(1,2,3-c,d)pyrene	1.15	NA	1000	350	30	3.66E+07	1.32E+09	70	365	**NA**
									Total Pathway Risk	**5E-08**

Table 6
Volatilization Factor for Inhalation Pathway
Residential and Recreational Receptors
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Equation:

$$VF = \frac{Q}{C_{VF}} x \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} \frac{m^2}{cm^2}$$

where:

VF = Volatilization Factor (m^3/kg)

Q/C_{VF} = Inverse of mean concentration at the center of 1 acre square source (g/m^2-s)/(kg/m^3)

π = pi (3.14)

D_A = Apparent Diffusivity (cm^2/s)

T = Exposure interval (s), 30 yrs for residential receptors

ρ_b = Dry soil bulk density (g/cm^3) , site-specific

Chemical	Q/C_{VF} (g/m^2-s)/(kg/m^3)	π	D_A (cm^2/s)	T (s)	2	ρ_b (g/cm^3)	10^{-4} (m^2/cm^2)	VF (m^3/kg)
Benz(a)anthracene	85.81	3.14	1.43E-10	9.50E+08	2	2	1.00E-04	9.80E+06
Benzo(a)pyrene	85.81	3.14	5.55E-11	9.50E+08	2	2	1.00E-04	1.57E+07
Benzo(b)fluoranthene	85.81	3.14	3.35E-11	9.50E+08	2	2	1.00E-04	2.02E+07
Carbazole	85.81	3.14	1.29E-08	9.50E+08	2	2	1.00E-04	1.03E+06
Dibenz(a,h)anthracene	85.81	3.14	8.55E-12	9.50E+08	2	2	1.00E-04	4.01E+07
Indeno(1,2,3-c,d)pyrene	85.81	3.14	1.03E-11	9.50E+08	2	2	1.00E-04	3.66E+07

Table 6
Volatilization Factor for Inhalation Pathway
Residential and Recreational Receptors
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Equation:

$$D_A = \frac{\left(\theta_a^{3.33} \bullet D_i \bullet H'\right) + \left(\theta_w^{3.33} \bullet D_w\right)}{\eta^2} \bullet \frac{1}{\left((\rho_b \bullet K_d) + \theta_w + (\theta_a \bullet H')\right)}$$

where:

D_A =	Apparent Diffusivity (cm^2/s)	calculated
D_i =	Diffusivity in Air (cm^2/s)	chemical-specific
D_w =	Diffusivity in Water (cm^2/s)	chemical-specific
θ_a =	Air-filled soil porosity (cm^3/cm^3)	0.05
θ_w =	Water-filled soil porosity (cm^3/cm^3)	0.2
H' =	Unitless Henry's Law constant	chemical-specific
η =	Total soil porosity (cm^3/cm^3)	0.25
ρ_b =	Dry soil bulk density (g/cm^3)	2
K_d =	$K_{oc} \times f_{oc}$	calculated
K_{oc} =	Organic carbon partition coefficient (cm^3/g)	chemical-specific
f_{oc} =	Organic carbon content of soil (g/g)	0.006

Chemical	Θ_a (cm^3/cm^3)	Θ_w (cm^3/cm^3)	D_i (cm^2/s)	D_w (cm^2/s)	H' (unitless)	η	ρ_b (g/cm^3)	K_{oc} (cm^3/g)	f_{oc} (g/g)	K_d (cm^3/g)	D_A (cm^2/s)
Benz(a)anthracene	0.05	0.2	5.10E-02	9.00E-06	1.37E-04	0.25	2	3.98E+05	0.006	2.39E+03	1.43E-10
Benzo(a)pyrene	0.05	0.2	4.30E-02	9.00E-06	4.63E-05	0.25	2	1.02E+06	0.006	6.12E+03	5.55E-11
Benzo(b)fluoranthene	0.05	0.2	2.26E-02	5.56E-06	4.55E-03	0.25	2	1.23E+06	0.006	7.38E+03	3.35E-11
Benzo(k)fluoranthene	0.05	0.2	3.90E-02	7.03E-06	6.26E-07	0.25	2	3.39E+03	0.006	2.03E+01	1.29E-08
Chrysene	0.05	0.2	2.02E-02	5.18E-06	6.03E-07	0.25	2	3.80E+06	0.006	2.28E+04	8.55E-12
Dibenz(a,h)anthracene	0.05	0.2	2.02E-02	5.18E-06	6.03E-07	0.25	2	3.80E+06	0.006	2.28E+04	8.55E-12
Indeno(1,2,3-c,d)pyrene	0.05	0.2	1.90E-02	5.66E-06	6.56E-05	0.25	2	3.47E+06	0.006	2.08E+04	1.03E-11

Table 7
Risk Calculation for Dermal Contact with Gravel Fines
Residential Receptors
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Residential Land Use - Gravel Fines

Equation:

$$Risk_{soil\text{-}derm} = \frac{(C_{soil} \times SF_{abs} \times CF_2 \times EF \times EV \times SCR_{adj} \times ABSd)}{AT_c \times CF_1}$$

where:

C_{soil} = Concentration in Soil (mg/kg)	Calculated, 95% UCL	See Table 2
SF_{abs} = Slope Factor, absorbed (SF_o – ABS_{gi})	See Table 3	ABS_{gi} values are as presented in Exhibit 4-1 in RAGS Part E.
CF_2 = Unit conversion Factor (kg/mg)	1E-06	
EF = Exposure frequency (day/yr)	350	USEPA, 1989 Exhibit 6-14 of *RAGS, Volume I, Human Health Evaluation Manual (Part A).* Default exposure frequency
SCR_{adj} = Age-adjusted Soil Contact Rate	360.28	Calculated using:

$$SCRadj = \left(\frac{SAa \times EDa \times AFa}{BWa}\right) + \left(\frac{SAc \times EDc \times AFc}{BWc}\right) = \left(\frac{5700cm^2 \times 24yr \times 0.07mg/cm^2-event}{70kg}\right) + \left(\frac{2800cm^2 \times 6yr \times 0.2mg/cm^2-event}{15kg}\right) = 360.28\ ^{mg-yr}/_{kg-event}$$

where,

SAc = Skin Surface Area Exposed, child (cm^2)	2,800	USEPA, 2004 *RAGS, Volume 1, Human Health Evaluation Manual (Part E)* Exhibit 3-5. Default skin surface area
SAa = Skin Surface Area Exposed, adult (cm^2)	5,700	USEPA, 2004. *RAGS, Volume 1, Human Health Evaluation Manual (Part E)* Exhibit 3-5. Default skin surface area.
AFc = Soil-to-skin adherence factor, child (mg/cm^2-event)	0.2	USEPA, 2004 *RAGS, Volume 1, Human Health Evaluation Manual (Part E)* Exhibit 3-5. Default soil-to-skin adherence factor.
AFa = Soil-to-skin adherence factor, adult (mg/cm^2-event)	0.1	USEPA, 2004. *RAGS, Volume 1, Human Health Evaluation Manual (Part E)* Exhibit 3-5 Default soil-to-skin adherence factor.
EDc = Exposure Duration, Child (years)	6	USEPA, 1989 Exhibit 6-14 of RAGS, *Volume I, Human Health Evaluation Manual (Part A).*
EDa = Exposure Duration, adult (years)	24	USEPA, 1989 Exhibit 6-14 of RAGS, *Volume I, Human Health Evaluation Manual (Part A)*
BWc = Body Weight, child (kg)	15	USEPA, 1989. Exhibit 6-14 of RAGS, *Volume I, Human Health Evaluation Manual (Part A).*
BWa = Body Weight, adult (kg)	70	70 kg body weight and 70 year lifetime are used to be consistent with the development of cancer slope factors.
EV = Event Frequency (events/day)	1	USEPA, 2004 *RAGS, Part E*, Exhibit 3-5. Default event frequency.
ABSd = Dermal Soil Absorption Factor (unitless)	chemical-specific	USEPA, 2004. *RAGS, Part E*, Exhibit 3-4. Recommended dermal absorption fraction from soil.
AT_c = Averaging Time (yr)	70	TACO Default Value
CF_1 = Unit conversion factor (days/year)	365	

Chemical	C_{soil} (mg/kg)	SF_o $(mg/kg\text{-}day)^{-1}$	ABS_{gi} (unitless)	SF_{abs} $(mg/kg\text{-}day)^{-1}$	CF_2 (kg/mg)	EF (day/yr)	EV (events/day)	SCR_{adj} (mg-yr/kg-event)	ABSd (unitless)	AT_c (yr)	CF_1 (day/yr)	$Risk_{soil\text{-}derm}$
Benz(a)anthracene	2.46	7.30E-01	1.00E+00	7.30E-01	1.0E-06	350	1	360	1.30E-01	70	365	**1.15E-06**
Benzo(a)pyrene	2.06	7.30E+00	1.00E+00	7.30E+00	1.0E-06	350	1	360	1.30E-01	70	365	**9.64E-06**
Benzo(b)fluoranthene	2.48	7.30E-01	1.00E+00	7.30E-01	1.0E-06	350	1	360	1.30E-01	70	365	**1.16E-06**
Benzo(k)fluoranthene	1.52	7.30E-02	1.00E+00	7.30E-02	1.0E-06	350	1	360	1.30E-01	70	365	**7.13E-08**
Chrysene	1.84	7.30E-03	1.00E+00	7.30E-03	1.0E-06	350	1	360	1.30E-01	70	365	**8.64E-09**
Dibenz(a,h)anthracene	0.29	7.30E+00	1.00E+00	7.30E+00	1.0E-06	350	1	360	1.30E-01	70	365	**1.36E-06**
Indeno(1,2,3-c,d)pyrene	1.15	7.30E-01	1.00E+00	7.30E-01	1.0E-06	350	1	360	1.30E-01	70	365	**5.37E-07**
											Total Pathway Risk	**1E-05**

Table 8
Risk Characterization Summary
Residential Land Use
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Risk Summary - Gravel Fines

Exposure Receptor	Risk Estimate for Ingestion Pathway	Risk Estimate for Dermal Pathway[1]	Risk Estimate for Inhalation Pathway	Total Risk Estimate
Residential	3E-05	1E-05	5E-08	5E-05

Table 9
Risk Calculation for the Ingestion Route for Gravel Fines
Recreational Land Use
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Recreational Land Use - Gravel Fines

Equation:

$$Risk_{soiling} = \frac{Csoil \times SF_o \times CF_2 \times EF \times IR \times ED}{AT_c \times CF_1}$$

where:

C_{soil} =	Concentration in Soil (mg/kg)	Calculated, 95% UCL	(See Table 2)
SF_o =	Oral Slope Factor $(mg/kg.day)^{-1}$	Chemical-specific	(See Table 3)
CF_2 =	Unit conversion Factor (kg/mg)	1E-06	
EF =	Exposure frequency (dy/yr)	52	
ED =	Exposure duration (yr)	12	
$IF_{soil-adj}$ =	Age-adjusted Soil Ingestion Factor for Carcinogens (mg-yr/kg-d)	100	
BW=	Body Weight (kg)	43	
AT_c =	Averaging Time (yr)	70	
CF_1 =	Unit conversion factor (dy/yr)	365	

Chemical	Csoil (mg/kg)	SF_o $(mg/kg.day)^{-1}$	CF_2 (kg/mg)	EF (dy/yr)	IR (mg-yr/kg-d)	ED (yr)	BW (kg)	AT_c (yr)	CF_1 (dy/yr)	Risk
Benz(a)anthracene	2.46	7.30E-01	1.0E-06	52	100	12	43	70	365	**1.02E-07**
Benzo(a)pyrene	2.06	7.30E+00	1.0E-06	52	100	12	43	70	365	**8.53E-07**
Benzo(b)fluoranthene	2.48	7.30E-01	1.0E-06	52	100	12	43	70	365	**1.03E-07**
Benzo(k)fluoranthene	1.52	7.30E-02	1.0E-06	52	100	12	43	70	365	**2.26E-08**
Chrysene	1.84	7.30E-03	1.0E-06	52	100	12	43	70	365	**2.74E-09**
Dibenz(a,h)anthracene	0.29	7.30E+00	1.0E-06	52	100	12	43	70	365	**1.21E-07**
Indeno(1,2,3-c,d)pyrene	1.15	7.30E-01	1.0E-06	52	100	12	43	70	365	**4.75E-08**
									Total Pathway Risk	**1E-06**

Table 10
Risk Calculations for Inhalation Route for Gravel Fines
Recreational Receptors
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Recreational Land Use - Gravel Fines

Equation:

$$Risk_{soilinh} = \frac{Csoil \times URF \times CF_2 \times EF \times ED \times [(1/VF) + (1/PEF)]}{AT_c \times CF_1}$$

where:

C_{soil} =	Concentration in Soil (mg/kg)	Calculated, 95% UCL	(See Table 2)
URF =	Inhalation Unit Risk Factor((μg/m^3)$^{-1}$	See Table 3	
CF_2 =	Unit conversion Factor (μg/mg)	1000	
EF =	Exposure frequency (dy/yr)	52	
ED =	Exposure duration (yr)	12	
VF =	Volatilization Factor (m^3/kg)	calculated	
PEF =	Particulate Emission Factor (m^3/kg)	1.32E+09	
BW =	Body Weight (kg)	43	
AT_c =	Averaging Time (yr)	70	
CF_1 =	Unit conversion factor (dy/yr)	365	

Chemical	Csoil (mg/kg)	URF (μg/m^3)$^{-1}$	CF_2 (μg/mg)	EF (dy/yr)	ED (yr)	VF (m^3/kg)	PEF (m^3/kg)	AT_c (yr)	CF_1 (dy/yr)	Risk
Benz(a)anthracene	2.46	NA	1000	52	12	9.80E+06	1.32E+09	43	365	**NA**
Benzo(a)pyrene	2.06	8.86E-04	1000	52	12	1.57E+07	1.32E+09	43	365	**4.66E-09**
Benzo(b)fluoranthene	2.48	NA	1000	52	12	2.02E+07	1.32E+09	43	365	**NA**
Benzo(k)fluoranthene	1.52	NA	1000	52	12	1.03E+06	1.32E+09	43	365	**NA**
Chrysene	1.84	NA	1000	52	12	4.01E+07	1.32E+09	43	365	**NA**
Dibenz(a,h)anthracene	0.29	NA	1000	52	12	4.01E+07	1.32E+09	43	365	**NA**
Indeno(1,2,3-c,d)pyrene	1.15	NA	1000	52	12	3.66E+07	1.32E+09	43	365	**NA**
									Total Pathway Risk	**5E-09**

Table 11
Risk Calculation for Dermal Contact with Gravel Fines
Recreational Receptors
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Recreational Land Use - Gravel Fines

Equation:

$$Risk_{soil\text{-}derm} = \frac{C_{soil} \times SF_{abs} \times CF_2 \times EF \times ED \times EV \times SA \times SSAF \times ABSd}{BW \times AT_c \times CF_1}$$

where:

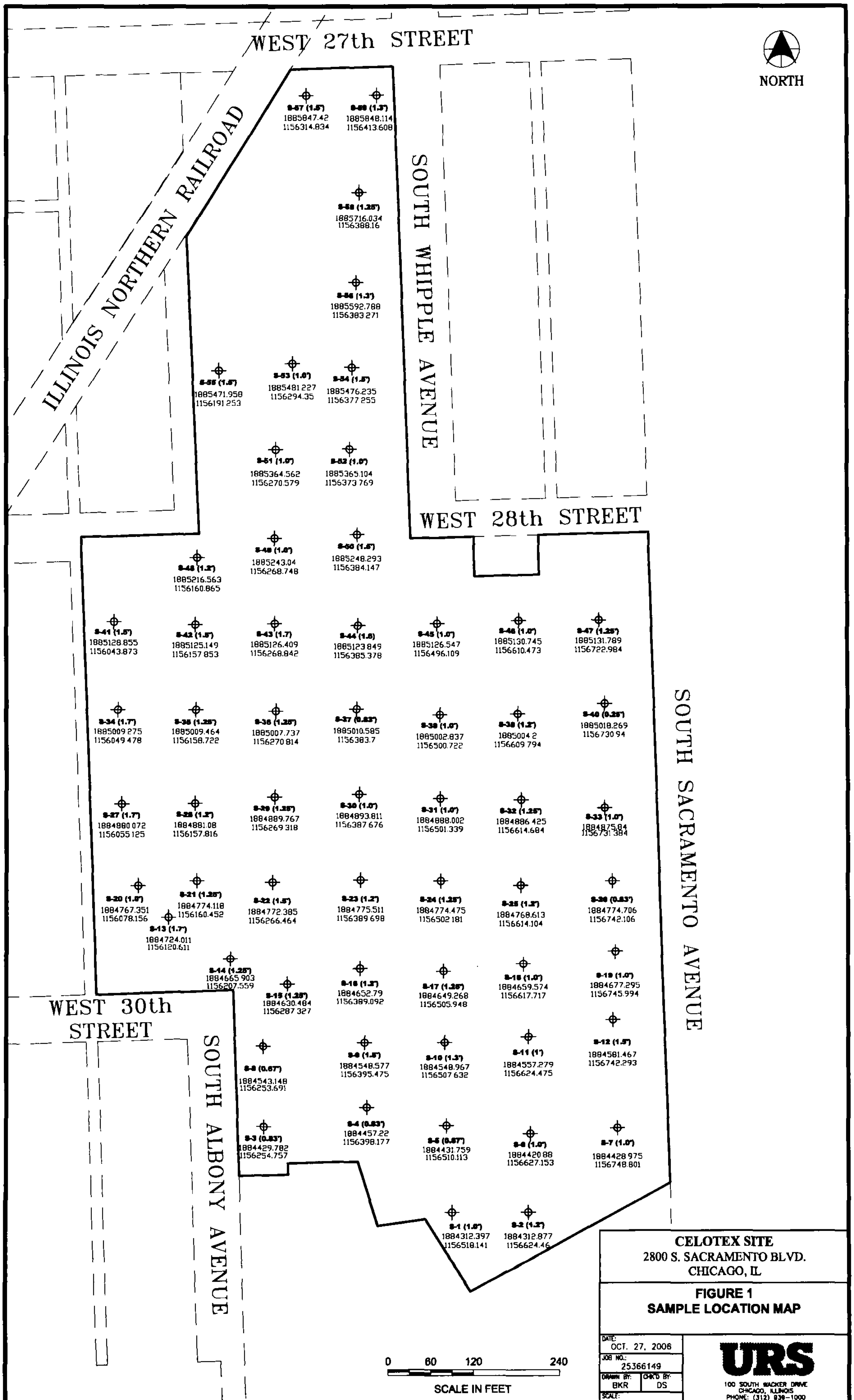
C_{soil} =	Concentration in Soil (mg/kg)	Calculated, 95% UCL	See Table 2
SF_{abs} =	Slope Factor, absorbed ($SF_o \div ABS_{gi}$)	See Table 3	ABS_{gi} values are as presented in Exhibit 4-1 in RAGS Part E.
CF_2 =	Unit conversion Factor (kg/mg)	1E-06	
EF =	Exposure frequency (day/yr)	52	Conservative assumption (3 days/week during June, July, and August and 1 day/week during April, May, September, and October)
ED =	Exposure duration (yr)	12	Recreational adolescent is assumed to range in age from 7 to 18. Therefore, total exposure duration is *12* years.
EV =	Event Frequency (events/day)	1	USEPA, 2004. *RAGS, Part E*, Exhibit 3-5. Default event frequency.
SA =	Skin Surface Area (cm^2)	4,373	USEPA, 1997. *Exposure Factors Handbook* Average surface area of head, hands, forearms, and lower legs of males and females aged 7-18
SSAF =	Soil-to-skin Adherence Factor (mg/cm^2-event)	0.07	USEPA, 2004 *RAGS, Part E*, Exhibit 3-5. Recommended soil-to-skin adherence factor for older children and adults, greater than 6 years of age.
ABSd =	Dermal Soil Absorption Factor (unitless)	chemical-specific	USEPA, 2004 *RAGS, Part E*, Exhibit 3-4 Recommended dermal absorption fraction from soil.
BW=	Body Weight (kg)	47	USEPA, 1997. *Exposure Factors Handbook*, Table 7-3. Body weight is the average of males and females aged 7 to 18.
AT_c =	Averaging Time (yr)	70	TACO Default Value
CF_1 =	Unit conversion factor (days/year)	365	

Chemical	C_{soil} (mg/kg)	SF_o (mg/kg day)$^{-1}$	ABS_{gi} (unitless)	SF_{abs} (mg/kg day)$^{-1}$	CF_2 (kg/mg)	EF (day/yr)	ED (yr)	EV (events/day)	SA (cm^2)	SSAF (mg/cm^2- event)	ABSd (unitless)	BW (kg)	AT_c (yr)	CF_1 (day/yr)	$Risk_{soil\text{-}derm}$
Benz(a)anthracene	2.46	7.30E-01	1.00E+00	7.30E-01	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**3.71E-08**
Benzo(a)pyrene	2.06	7.30E+00	1.00E+00	7.30E+00	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**3.11E-07**
Benzo(b)fluoranthene	2.48	7.30E-01	1.00E+00	7.30E-01	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**3.74E-08**
Benzo(k)fluoranthene	1.52	7.30E-02	1.00E+00	7.30E-02	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**2.30E-09**
Chrysene	1.84	7.30E-03	1.00E+00	7.30E-03	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**2.78E-10**
Dibenz(a,h)anthracene	0.29	7.30E+00	1.00E+00	7.30E+00	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**4.39E-08**
Indeno(1,2,3-c,d)pyrene	1.15	7.30E-01	1.00E+00	7.30E-01	1.0E-06	52	12	1	4,373	0.07	1.30E-01	47	70	365	**1.73E-08**
														Total Pathway Risk	**4E-07**

Table 12
Risk Characterization Summary
Recreational Land Use
Former Celotex Site - 2800 S. Sacramento Ave.
Chicago, IL

Risk Summary - Gravel Fines

Exposure Receptor	Risk Estimate for Ingestion Pathway	Risk Estimate for Dermal Pathway[1]	Risk Estimate for Inhalation Pathway	Total Risk Estimate
Residential	1E-06	4E-07	5E-09	2E-06


WEST 27th STREET
NORTH
ILLINOIS NORTHERN RAILROAD
SOUTH WHIPPLE AVENUE
WEST 28th STREET
SOUTH SACRAMENTO AVENUE
WEST 30th STREET
SOUTH ALBONY AVENUE
0 60 120 240
SCALE IN FEET
CELOTEX SITE
2800 S. SACRAMENTO BLVD.
CHICAGO, IL
FIGURE 1
SAMPLE LOCATION MAP
DATE: OCT. 27, 2006
JOB NO.: 25366149
DRAWN BY: BKR
CHK'D BY: DS
SCALE: 1"=120'
URS
100 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS
PHONE: (312) 939-1000
FAX: (312) 939-4198

Attachment A

Site Conceptual Exposure Model

TABLE OF CONTENTS

A SCEM for the Site is established in this Attachment based on current understanding of site history, features, environmental settings, and future redevelopment plans. The SCEM reviews physical properties as well as potential fate and transport mechanisms of COCs identified in the TACO Tier 1 risk evaluation. The SCEM also characterizes potential sources, release mechanisms, migration pathways, potential receptors, exposure routes, and exposure pathway completeness.

1.0 PHYSICAL AND CHEMICAL PROPERTIES OF COCs

The following discussion reviews the physical properties, and potential fate and transport mechanisms of the COCs in the media where elevated concentrations were found. The COCs are constituents that were found in soil above the TACO Tier 1 soil ROs. The COCs identified at the Site are listed below.

Area/Media	COCs	Tier 1 ROs Exceeded	Approach to Address Tier 1 RO Exceedances	Addressed in
Surface Soil	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Residential Ingestion	Tier 3 Formal Risk Assessment	Section 4.0 of this Report
Surface Soil	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Methylene chloride Dieldrin Chromium	Migration-to-Groundwater	Exposure Route Exclusion	Section 3.0 of this Report

Volatile Organic Chemicals

Methylene Chloride

Methylene chloride is used as solvent, chemical intermediate, grain fumigant, paint stripper and remover, metal degreaser, and refrigerant. If released to air, methylene chloride will exist solely as a vapor in the ambient atmosphere. Vapor-phase methylene chloride will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals. Methylene chloride will not be subject to direct photolysis. If released to soil, methylene chloride is expected to have very high mobility based upon its low organic carbon/water partition coefficient (Koc). Volatilization from moist soil surfaces is expected to be an important fate process based upon its Henry's Law constant. Methylene chloride may volatilize from dry soil surfaces based upon its vapor pressure. (HSDB, 2006).

Polycyclic Aromatic Hydrocarbons

PAHs are a class of organic compounds generally found in petroleum-derived products, asphalt, creosote oils, and coal products. In general, they have low vapor pressure, low solubility in water and high octanol water partition coefficients (Kow). They tend to be adsorbed to organic carbon in the soil, particularly the high molecular weight PAHs such as benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene which were potential COCs at the Site. Therefore, PAHs are not expected to be highly mobile in soil. PAHs also have slow biological degradation rates, which partly explains their persistence in soil and other media. Leaching to groundwater is not considered to be a significant pathway for PAHs, particularly in soils with higher organic carbon content. Most of the PAHs released to aquatic environments tend to remain near the sites of deposition (ATSDR, 1995).

Pesticide

Dieldrin

Dieldrin's former production and use as an insecticide resulted in its direct release to the environment. Dieldrin is also a degradation product of the insecticide aldrin, and the former use of aldrin has contributed to the occurrence of dieldrin in the environment. If released to air, dieldrin will exist in both the vapor and particulate phases in the ambient atmosphere. Vapor-phase dieldrin will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals. Dieldrin also undergoes direct photolysis in the environment yielding photodieldrin as the primary degradation product. Particulate-phase dieldrin will be removed from the atmosphere by wet and dry deposition. If released to soil, dieldrin is expected to have low to no mobility based on its high organic carbon partition coefficient (Koc) value. Volatilization from moist soil surfaces is expected to be an important fate process based upon its Henry's Law constant; however adsorption may attenuate this process.

If released into water, dieldrin is expected to adsorb to suspended solids and sediment in water based upon its Koc data. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. (HSDB, 2006).

Metal

Chromium

Chromium is a metallic element with oxidation states ranging from chromium(-II) to chromium(+VI). The important valence states of chromium are trivalent (III) and hexavalent (VI). Chromium compounds are stable in the trivalent state and occur in nature in this state in ores, such as ferrochromite. The hexavalent is the second most stable state. However, hexavalent chromium rarely occurs naturally, but is produced from anthropogenic sources. Chromium is widely distributed in the earth's crust but is rare in unpolluted waters. The production and use of chromium compounds may result in their release to the environment through various waste streams. Chromium compounds are released into the atmosphere mainly by anthropogenetic stationary point sources, including industrial, commercial, and residential fuel combustion, via the combustion of natural gas, oil, and coal. If released to air, chromium compounds will exist solely in the particulate phase in the ambient atmosphere. Particulate-phase chromium compounds will be removed from the atmosphere by wet and dry deposition. If released to soil, the fate of chromium is greatly dependent upon the speciation of chromium, which is a function of the oxidation reduction potential (i.e., redox) and the pH of the soil. In most soils, chromium will be present predominantly in the trivalent state. This form has very low solubility and low reactivity resulting in low mobility in the environment. Under oxidizing conditions, hexavalent

Receptor	Pathway
Current Industrial/Commercial Workers	- Direct contact (i.e., incidental ingestion and dermal contact) with soils - Inhalation of volatile organics and/or fugitive dusts
Future Recreational Users	- Direct contact (i.e., incidental ingestion and dermal contact) with soils - Inhalation of volatile organics and/or fugitive dusts
Future Construction Workers	- Direct contact (i.e., incidental ingestion and dermal contact) with soils - Inhalation of volatile organics and/or fugitive dusts

6.0 References

Agency for Toxic Substances Disease Registry (ATSDR). 1995. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs).* U.S. Department Of Health And Human Services Public Health Service. August.

City of Chicago (1997). *Memorandum of Understanding Between the City of Chicago and the Illinois Environmental Protection Agency.* July.

Illinois EPA (2001). *Tiered Approach to Corrective Action Objectives (TACO).* Title 35, Section 742 of the Illinois Administrative Code.

United States National Library of Medicine. 2006. *Hazardous Substance Data Bank.* http://toxnet.nlm.nih.gov/.

Table B-1
ProUCL Output

Chromium

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	12
Minimum	11
Maximum	25
Mean	15.45763
Median	16
Standard Deviation	2.654353
Variance	7.045587
Coefficient of Variation	0.171718
Skewness	0.916414

Gamma Statistics	
k hat	36.33252
k star (bias corrected)	34.4964
Theta hat	0.425449
Theta star	0.448094
nu hat	4287.237
nu star	4070.576
Approx.Chi Square Value (.05)	3923.277
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	3919.686

Log-transformed Statistics	
Minimum of log data	2.397895
Maximum of log data	3.218876
Mean of log data	2.724278
Standard Deviation of log data	0.166501
Variance of log data	0.027723

RECOMMENDATION
Data are Non-parametric (0.05)

Use Student's-t UCL
or Modified-t UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.145002324
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student	16.03526094

Gamma Distribution Test	
A-D Test Statistic	0.828703063
A-D 5% Critical Value	0.748163556
K-S Test Statistic	0.129629924
K-S 5% Critical Value	0.115404203
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	16.03797878
Adjusted Gamma UCL	16.05267238

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.139574601
Lilliefors 5% Critical Value	0.115347375
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	16.04371921
95% Chebyshev (MVUE) UCL	16.92349134
97.5% Chebyshev (MVUE) UCL	17.55912019
99% Chebyshev (MVUE) UCL	18.80768997

95% Non-parametric UCLs	
CLT UCL	16.02603469
Adj-CLT UCL (Adjusted for skewness)	16.07008804
Mod-t U	16.04213237
Jackknife UCL	16.03526094
Standard Bootstrap UCL	16.04249712
Bootstrap-t UCL	16.05841749
Hall's Bootstrap UCL	16.09956764
Percentile Bootstrap UCL	16
BCA Bootstrap UCL	16.01694915
95% Chebyshev (Mean, Sd) UCL	16.96391991
97.5% Chebyshev (Mean, Sd) UCL	17.615694
99% Chebyshev (Mean, Sd) UCL	18.895978

Table B-2
ProUCL Output

Benz(a)anthracene

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	33
Minimum	0.25
Maximum	9.9
Mean	1.617966
Median	1.1
Standard Deviation	1.479609
Variance	2.189244
Coefficient of Variation	0.914487
Skewness	3.703412

Gamma Statistics	
k hat	2.302614
k star (bias corrected)	2.196832
Theta hat	0.702665
Theta star	0.7365
nu hat	271.7085
nu star	259.2261
Approx.Chi Square Value (.05)	222.9372
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	222.0984

Log-transformed Statistics	
Minimum of log data	-1.386294
Maximum of log data	2.292535
Mean of log data	0.248582
Standard Deviation of log data	0.64227
Variance of log data	0.412511

Normal Distribution Test	
Lilliefors Test Statisitic	0.236523744
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1.939955152

Gamma Distribution Test	
A-D Test Statistic	1.762496844
A-D 5% Critical Value	0.761380126
K-S Test Statistic	0.174179842
K-S 5% Critical Value	0.11703147
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1.881332917
Adjusted Gamma UCL	1.888438118

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.123543472
Lilliefors 5% Critical Value	0.115347375
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	1.859766951
95% Chebyshev (MVUE) UCL	2.188875445
97.5% Chebyshev (MVUE) UCL	2.456944044
99% Chebyshev (MVUE) UCL	2.983512897

95% Non-parametric UCLs	
CLT UCL	1.934812184
Adj-CLT UCL (Adjusted for skewness)	2.034050071
Mod-t UCL (Adjusted for skewness)	1.955434257
Jackknife UCL	1.939955152
Standard Bootstrap UCL	1.927760848
Bootstrap-t UCL	2.153092142
Hall's Bootstrap UCL	3.402703754
Percentile Bootstrap UCL	1.962033898
BCA Bootstrap UCL	2.027118644
95% Ch	2.457615315
97.5% Chebyshev (Mean, Sd) UCL	2.8209322
99% Chebyshev (Mean, Sd) UCL	3.53459787

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Table B-4
ProUCL Output

Benzo(b)fluoranthene

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	35
Minimum	0.29
Maximum	8.7
Mean	1.617797
Median	1.2
Standard Deviation	1.516346
Variance	2.299304
Coefficient of Variation	0.937291
Skewness	3.017568

Gamma Statistics	
k hat	2.125563
k star (bias corrected)	2.028783
Theta hat	0.761114
Theta star	0.797422
nu hat	250.8165
nu star	239.3964
Approx.Chi Square Value (.05)	204.5702
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	203.7676

Log-transformed Statistics	
Minimum of log data	-1.237874
Maximum of log data	2.163323
Mean of log data	0.227761
Standard Deviation of log data	0.661991
Variance of log data	0.438232

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.252019972
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1.947780077

Gamma Distribution Test	
A-D Test Statistic	2.197791626
A-D 5% Critical Value	0.762258828
K-S Test Statistic	0.190232599
K-S 5% Critical Value	0.117128317
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1.89321232
Adjusted Gamma UCL	1.900669022

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.140173255
Lilliefors 5% Critical Value	0.115347375
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	1.856870459
95% Chebyshev (MVUE) UCL	2.192526505
97.5% Chebyshev (MVUE) UCL	2.46776414
99% Chebyshev (MVUE) UCL	3.008415176

95% Non-parametric UCLs	
CLT UCL	1.942509418
Adj-CLT UCL (Adjusted for skewness)	2.025376813
Mod-t UCL (Adjusted for skewness)	1.960705716
Jackknife UCL	1.947780077
Standard Bootstrap UCL	1.946036835
Bootstrap-t UCL	2.100829402
Hall's Bootstrap UCL	2.12267588
Percentile Bootstrap UCL	1.951355932
BCA Bootstrap UCL	2.039152542
95% Ch	2.478292821
97.5% Chebyshev (Mean, Sd) UCL	2.850630218
99% Chebyshev (Mean, Sd) UCL	3.582014937

Table B-5
ProUCL Output

Dibenz(a,h)anthracene

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	30
Minimum	0.073
Maximum	1
Mean	0.25439
Median	0.19
Standard Deviation	0.20084
Variance	0.040337
Coefficient of Variation	0.789497
Skewness	2.389727

Gamma Statistics	
k hat	2.559709
k star (bias corrected)	2.440853
Theta hat	0.099382
Theta star	0.104222
nu hat	302.0456
nu star	288.0207
Approx.Chi Square Value (.05)	249.7043
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	248.8153

Log-transformed Statistics	
Minimum of log data	-2.617296
Maximum of log data	0
Mean of log data	-1.576759
Standard Deviation of log data	0.611055
Variance of log data	0.373389

Normal Distribution Test	
Lilliefors Test Statisitic	0.234620247
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	0.298096159

Gamma Distribution Test	
A-D Test Statistic	1.697930781
A-D 5% Critical Value	0.760104166
K-S Test Statistic	0.149149784
K-S 5% Critical Value	0.116890839
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	0.293425239
Adjusted Gamma UCL	0.294473649

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.099264777
Lilliefors 5% Critical Value	0.115347375
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-l	0.291017969
95% Chebyshev (MVUE) UCL	0.34069401
97.5% Chebyshev (MVUE) UCL	0.380744741
99% Chebyshev (MVUE) UCL	0.459416649

95% Non-parametric UCLs	
CLT UCL	0.29739806
Adj-CLT UCL (Adjusted for skewness)	0.306090205
Mod-t UCL (Adjusted for skewness)	0.299451958
Jackknife UCL	0.298096159
Standard Bootstrap UCL	0.297334655
Bootstrap-t UCL	0.314077099
Hall's Bootstrap UCL	0.306282126
Percentile Bootstrap UCL	0.296644068
BCA Bootstrap UCL	0.305220339
95% Chebyshev (Mean, Sd) UCL	0.368362602
97.5% Chebyshev (Mean, Sd) UCL	0.417678712
99% Chebyshev (Mean, Sd) UCL	0.514550659

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL

Table B-6
ProUCL Output

Indeno(1,2,3-cd)pyrene

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	43
Minimum	0.14
Maximum	3.7
Mean	0.720508
Median	0.49
Standard Deviation	0.750658
Variance	0.563488
Coefficient of Variation	1.041845
Skewness	2.860216

Gamma Statistics	
k hat	1.867985
k star (bias corrected)	1.784302
Theta hat	0.385714
Theta star	0.403804
nu hat	220.4223
nu star	210.5477
Approx.Chi Square Value (.05)	177.9624
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	177.2153

Log-transformed Statistics	
Minimum of log data	-1.966113
Maximum of log data	1.308333
Mean of log data	-0.618738
Standard Deviation of log data	0.68485
Variance of log data	0.46902

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.272585607
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	0.8838649

Gamma Distribution Test	
A-D Test Statistic	3.564424148
A-D 5% Critical Value	0.764426835
K-S Test Statistic	0.211900434
K-S 5% Critical Value	0.11737918
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	0.852435097
Adjusted Gamma UCL	0.856028648

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.164557123
Lilliefors 5% Critical Value	0.115347375
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	0.814925294
95% Chebyshev (MVUE) UCL	0.965697967
97.5% Chebyshev (MVUE) UCL	1.090323434
99% Chebyshev (MVUE) UCL	1.33512603

95% Non-parametric UCLs	
CLT UCL	0.88125569
Adj-CLT UCL (Adjusted for skewness)	0.920139559
Mod-t UCL (Adjusted for skewness)	0.889929998
Jackknife UCL	0.8838649
Standard Bootstrap UCL	0.875544295
Bootstrap-t UCL	0.959905367
Hall's Bootstrap UCL	0.927953155
Percentile Bootstrap UCL	0.882033898
BCA Bootstrap UCL	0.941016949
95% Ch	1.146492195
97.5% Chebyshev (Mean, Sd) UCL	1.330815692
99% Chebyshev (Mean, Sd) UCL	1.692883508

Table B-7
ProUCL Output

Benzo(k)fluoranthene

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	45
Minimum	0.14
Maximum	6.4
Mean	0.945424
Median	0.69
Standard Deviation	1.015199
Variance	1.030629
Coefficient of Variation	1.073803
Skewness	3.756763

Gamma Statistics	
k hat	1.966008
k star (bias corrected)	1.877341
Theta hat	0.480885
Theta star	0.503597
nu hat	231.9889
nu star	221.5262
Approx.Chi Square Value (.05)	188.071
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	187.3024

Log-transformed Statistics	
Minimum of log data	-1.966113
Maximum of log data	1.856298
Mean of log data	-0.331502
Standard Deviation of log data	0.670636
Variance of log data	0.449753

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.292122763
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1.166348863

Gamma Distribution Test	
A-D Test Statistic	2.896198052
A-D 5% Critical Value	0.763279775
K-S Test Statistic	0.193607285
K-S 5% Critical Value	0.117243909
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1.113601511
Adjusted Gamma UCL	1.118171295

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.128958034
Lilliefors 5% Critical Value	0.115347375
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	1.070610664
95% Chebyshev (MVUE) UCL	1.265881281
97.5% Chebyshev (MVUE) UCL	1.426482834
99% Chebyshev (MVUE) UCL	1.741953486

95% Non-parametric UCLs	
CLT UCL	1.162820138
Adj-CLT UCL (Adjusted for skewness)	1.23189076
Mod-t UCL (Adjusted for skewness)	1.177122485
Jackknife UCL	1.166348863
Standard Bootstrap UCL	1.156921324
Bootstrap-t UCL	1.318180542
Hall's Bootstrap UCL	1.417142651
Percentile Bootstrap UCL	1.181694915
BCA Bootstrap UCL	1.248474576
95% Ch	1.521529081
97.5% Chebyshev (Mean, Sd) UCL	1.770810327
99% Chebyshev (Mean, Sd) UCL	2.260475065

Table B-8
ProUCL Output

Chrysene

Raw Statistics	
Number of Valid Samples	59
Number of Unique Samples	36
Minimum	0.25
Maximum	8.6
Mean	1.604746
Median	1.2
Standard Deviation	1.336323
Variance	1.78576
Coefficient of Variation	0.832732
Skewness	3.257054

Gamma Statistics	
k hat	2.524277
k star (bias corrected)	2.407223
Theta hat	0.635725
Theta star	0.666638
nu hat	297.8647
nu star	284.0523
Approx.Chi Square Value (.05)	246.0091
Adjusted Level of Significance	0.045932
Adjusted Chi Square Value	245.1269

Log-transformed Statistics	
Minimum of log data	-1.386294
Maximum of log data	2.151762
Mean of log data	0.262003
Standard Deviation of log data	0.619629
Variance of log data	0.38394

Normal Distribution Test	
Lilliefors Test Statisitic	0.221902895
Lilliefors 5% Critical Value	0.115347375
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1.895553221

Gamma Distribution Test	
A-D Test Statistic	1.445126365
A-D 5% Critical Value	0.760280014
K-S Test Statistic	0.160390013
K-S 5% Critical Value	0.116910221
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1.852906175
Adjusted Gamma UCL	1.859575079

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.113185489
Lilliefors 5% Critical Value	0.115347375
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-I	1.844790081
95% Chebyshev (MVUE) UCL	2.162919506
97.5% Chebyshev (MVUE) UCL	2.420118427
99% Chebyshev (MVUE) UCL	2.925335903

95% Non-parametric UCLs	
CLT UCL	1.8909083
Adj-CLT UCL (Adjusted for skewness)	1.969733473
Mod-t UCL (Adjusted for skewness)	1.907848355
Jackknife UCL	1.895553221
Standard Bootstrap UCL	1.887560541
Bootstrap-t UCL	2.034269481
Hall's Bootstrap UCL	2.375897253
Percentile Bootstrap UCL	1.906779661
BCA Bootstrap UCL	1.961864407
95% Chebyshev (Mean, Sd) UCL	2.363082894
97.5% Chebyshev (Mean, Sd) UCL	2.691215977
99% Chebyshev (Mean, Sd) UCL	3.335769879

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL